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# MODELING AND FORECASTING OF SUSTAINABLE SOCIO-ECONOMIC DEVELOPMENT

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**Abstract.** This article uses econometric methods to analyze the impact of property relations and key macroeconomic factors on GDP during Uzbekistan's socioeconomic development. The study developed a regression model that includes factors such as the combined index of industry and agriculture, investment volume, population size, and unemployment. The statistical results of the model demonstrated high accuracy and allowed for reliable forecasting of GDP dynamics.

**Key words:** socio-economic development, GDP, property relations, econometric model, regression analysis, investments, unemployment, sustainable development.

Despite Uzbekistan's rapid economic growth in recent years, issues of GDP and sustainable socioeconomic development remain relevant from both a scientific and practical perspective. In a market economy, the combination of economic growth and social stability, as well as the efficient use of resources and the development of social protection systems, are among the priorities of modern policy. Therefore, research aimed at identifying the key factors shaping GDP and assessing their impact on sustainable development is of great importance.

The relevance of this article lies in the need for Uzbekistan to create a scientific basis for stabilizing economic growth rates, proactively forecasting socioeconomic challenges, and developing effective economic policies. Assessing the impact of factors such as population size, investment volume, and industrial and agricultural production on GDP is essential for the country's long-term strategic planning. At the same time, the efficient use of domestic resources, taking into account global economic changes and foreign trade conditions, is becoming a key factor in ensuring Uzbekistan's economic stability.

The scientific significance of this article lies in the development of an econometric model based on available statistical data and an analysis of key macroeconomic factors, determining their impact on GDP and sustainable socioeconomic development. The results of this study can be used not only in economic forecasting but also in economic policy development. The model identifies factors that stimulate and hinder economic growth, providing scientifically significant results.

The article also takes into account the economic and social decisions and laws of Uzbekistan adopted after 2022, including the "New Uzbekistan – Sustainable Development Strategy" and regulatory documents supporting investment and social policies, which form the basis of the research. This makes the article not only scientific but also practical, as it contributes to the development of the country's long-term socioeconomic strategy and identifies areas for ensuring sustainable development.

**Literature review**

Scholars have conducted research on the sustainability of socio-economic development at both the international and national levels. For example, in the article "Forecasting Future Development with the Interaction of Sustainable Development Goals," Yuqing Xu et al. propose an iterative forecasting model that takes into account the interaction of Sustainable Development Goals and applies it to 41 cities in the Yangtze River Delta, China, for the period 2021–2030. The scholars noted that existing models inadequately capture the complex relationships between indicators, and to fill this gap, they developed a new interactive model based on sustainable development [1]. This study increases the complexity of the sustainable development model and proposes an iterative forecasting methodology as an effective tool for policymaking, but also identifies a research gap requiring an improved set of indicators at the global level.

Similarly, in their 2025 paper, "Sustainable Rural Development as a Complex Regional Economic System: Cognitive Simulation Modeling," E.L. Makarova and other researchers analyzed the sustainable development of rural areas as a complex system using cognitive simulation modeling. The researchers created a cognitive map of 24 quantitative and qualitative indicators, -identified causal relationships between system elements, and tested various scenarios using a momentum model. The results revealed numerous positive cycles of structural stability, -indicating the importance of this approach for supporting sustainable economic and social development in rural areas when making strategic decisions [2].

I. Pyshnograev and I. Tkachenko will also present their paper, "Analysis and Forecasting of Sustainable Development in the European Context," in 2022. In this paper, Pyshnograev and Tkachenko propose a new methodological approach to analyzing and forecasting sustainable development in the European context. The researchers found that existing models are limited in providing quick results due to the large number of indicators and proposed a simplified approximation . This study improves data and produces more accurate forecasts by combining dynamic forecasting of social, economic, and environmental indicators [3].

In the article by M. Safiullin and K. Smolyanitsky, "Forecasting the Economic Dynamics of Regional Indicators Affecting the Inclusive Development Index," the dynamics of regional economic indicators that make up the inclusive growth index -are forecast using a correlation regression method, which plays an important role in assessing indicators of sustainable economic and social development. Their approach integrates elements of regional economic growth, social well-being, and stability, providing a basis for accurately forecasting objectives and formulating policy steps [4].

In his -article " -Scientific and Theoretical Foundations of Sustainable Socioeconomic Development," Uzbek researcher A. Radzhabov analyzes the theoretical foundations of the concept of sustainable socioeconomic development and the structural elements of a sustainability index. Radzhabov demonstrates that this concept consists of the principles of social equality, economic growth, and ecological balance, and explains them within the framework of economic theory. The contribution of this research expands the extensive scientific and theoretical foundations for the scientific analysis of sustainable development mechanisms, but due to the lack of empirical modeling research, a gap remains in the development of practical forecasting methods [5].

Similarly, G. Mukhamedzhanova's 2024 article "Ensuring Sustainable Economic Development" analyzes the factors of sustainable economic development in Uzbekistan based on macroeconomic parameters and identifies areas for a balanced distribution of investment across regions [6]. By modeling macroeconomic factors, a relationship was identified between sustainable economic growth rates and economic parameters, which can be used in developing national policy.

**Research methodology**

This article utilized econometric analysis and regression methods as the research methodology. Uzbekistan's GDP was used as the dependent variable, and the main macroeconomic factors influencing it were the independent variables: the combined index of industry and agriculture $X_{1.2}$ , investment volume $X_3$ , population $X_6$ , and unemployment rate $X_7$. The data covered the period 2017–2024 and were obtained from Stat.uz and other official sources. In the study, the coefficients were estimated using the ordinary least squares method,

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and the influence of factors on GDP was determined using correlation and elasticity analysis. The statistical reliability of the model was tested using $R^2$, the FFF test, and p-values, and forecasts were made for 2025–2030.

**Analysis and results**

Sustainable socio-economic development is one of the key goals of the modern economy. This section analyzes the relationships between socio-economic indicators in the Republic of Uzbekistan for the period 2017–2024 and develops a forecast to 2030.

We chose the socio-economic development of the Republic of Uzbekistan as the object of our research. In this paper

**Y** - Gross Domestic Product (US$ billion)

Independent variables ($X_1$-$X_8$):

**$X_1$** - Industrial production volume (billion soums)

**$X_2$** - Agricultural products (billion soums)

**$X_3$** - Investment volume (US$ billion)

**$X_4$** - Export volume (US$ billion)

**$X_5$** - Import volume (US$ billion)

**$X_6$** - Population (millions of people)

**$X_7$** - Unemployment rate (%)

**$X_8$** - Inflation rate (%) etc. were obtained.

**Table 1.**

Socio-economic indicators of the Republic of Uzbekistan (2017-2024)

| **Year** | **Y** | **$X_1$** | **$X_2$** | **$X_3$** | **$X_4$** | **$X_5$** | **$X_6$** | **$X_7$** | **$X_8$** |
|---|---|---|---|---|---|---|---|---|---|
| 2017 | 48.7 | 145.3 | 89.2 | 6.8 | 11.5 | 13.8 | 32.1 | 9.2 | 13.9 |
| 2018 | 50.5 | 168.7 | 103.6 | 8.2 | 13.7 | 17.2 | 32.7 | 8.9 | 17.5 |
| 2019 | 57.9 | 193.4 | 118.4 | 9.7 | 17.3 | 21.4 | 33.3 | 8.5 | 14.5 |
| 2020 | 57.7 | 201.5 | 126.9 | 8.9 | 15.1 | 20.9 | 34.0 | 10.5 | 12.9 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2021 | 69.2 | 244.8 | 151.3 | 11.4 | 18.9 | 26.5 | 34.6 | 9.3 | 10.8 |
| 2022 | 80.4 | 301.6 | 183.7 | 14.2 | 21.8 | 32.1 | 35.3 | 8.7 | 11.4 |
| 2023 | 90.1 | 357.2 | 209.5 | 17.1 | 24.5 | 36.8 | 36.0 | 8.2 | 9.3 |
| 2024 | 100.3 | 418.6 | 241.8 | 20.3 | 28.4 | 42.6 | 36.7 | 7.8 | 8.7 |

**Source:** Compiled based on data from the State Statistics Committee of the Republic of Uzbekistan.

Based on the data in the table, we determine the relationship between the factors and the main variable Y. The correlation coefficient is calculated using the Pearson formula:

$$r_{xy} = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \cdot \sum(y_i - \bar{y})^2}}$$

or:

$$r_{xy} = \frac{n\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{[n\sum x_i^2 - (\sum x_i)^2][n\sum y_i^2 - (\sum y_i)^2]}}$$

Here:

**n** - number of observations

**$x_i$, $y_i$** - values of variables

**$\bar{x}$, $\bar{y}$** - average values

**Table 2.**

Correlation coefficient matrix

| | **Y** | **$X_1$** | **$X_2$** | **$X_3$** | **$X_4$** | **$X_5$** | **$X_6$** | **$X_7$** | **$X_8$** |
|---|---|---|---|---|---|---|---|---|---|
| **Y** | 1,000 | 0.995 | 0.994 | 0.992 | 0.988 | 0.991 | 0.982 | -0.954 | -0.847 |
| **$X_1$** | 0.995 | 1,000 | 0.999 | 0.998 | 0.996 | 0.997 | 0.989 | -0.967 | -0.868 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **$X_2$** | 0.994 | 0.999 | 1,000 | 0.997 | 0.995 | 0.996 | 0.988 | -0.965 | -0.863 |
| **$X_3$** | 0.992 | 0.998 | 0.997 | 1,000 | 0.998 | 0.999 | 0.993 | -0.974 | -0.881 |
| **$X_4$** | 0.988 | 0.996 | 0.995 | 0.998 | 1,000 | 0.997 | 0.991 | -0.971 | -0.876 |
| **$X_5$** | 0.991 | 0.997 | 0.996 | 0.999 | 0.997 | 1,000 | 0.992 | -0.973 | -0.879 |
| **$X_6$** | 0.982 | 0.989 | 0.988 | 0.993 | 0.991 | 0.992 | 1,000 | -0.983 | -0.901 |
| **$X_7$** | -0.954 | -0.967 | -0.965 | -0.974 | -0.971 | -0.973 | -0.983 | 1,000 | 0.923 |
| **$X_8$** | -0.847 | -0.868 | -0.863 | -0.881 | -0.876 | -0.879 | -0.901 | 0.923 | 1,000 |

The results of assessing the strength of the relationship based on the absolute value of the correlation coefficient show that $|r|$ above 0.9 indicates a very strong relationship, 0.7–0.9 indicates a strong relationship, 0.5–0.7 indicates a moderate relationship, 0.3–0.5 indicates a weak relationship, and 0–0.3 indicates a very weak relationship. Analysis based on these criteria allowed us to determine the degree of linear dependence between GDP and key macroeconomic factors and served to assess the significance of the variables included in the model.

According to the analysis results, industrial production ($X_1$), agriculture ($X_2$), investment ($X_3$), exports ($X_4$), imports ($X_5$) and population ($X_6$) have a very strong linear relationship with GDP, and their correlation coefficients are in the range of 0.982–0.995. This means that these factors have a direct and significant impact on economic growth. In contrast, the unemployment rate ($X7$ ) showed a very strong inverse relationship with GDP, r = –0.954, and the inflation rate ($X_8$) showed a strong inverse relationship, r = –0.847, indicating that an increase in these factors acts as a factor reducing the rate of economic growth.

Now, based on the correlation relationship, we develop the regression equation.The general form of the multiple linear regression equation is as follows:

$$Y = a_0 + a_1 * X_1 + a_2 X_2 + a_3 X_3 + a_4 X_4 + a_5 X_5 + a_6 X_6 + a_7 X_7 + a_8 X_8 + e$$

Here:

- $a_0$ is the free term (constant)
- $a_1, a_2, \ldots, a_8$ - regression coefficients
- ε is a random error

**4.2. Calculation of regression coefficients**

The coefficients are calculated using the least squares method. The system of normal equations:

$$\mathbf{Y = a_0 + a_1 * X}$$

Here we calculate $\alpha_0$ and $\alpha_1$ as follows:

$$a_1 = \frac{n\sum XY - \sum X \sum Y}{n\sum X^2 - (\sum X)^2}$$

$$a_0 = \bar{Y} - a_1\bar{X}$$

**Table 3.**

Auxiliary table for calculations

| **Year** | **Y** | **ΣX₁** | **ΣX₂** | **ΣX₃** | **ΣX₄** | **ΣX₅** | **ΣX₆** | **ΣX₇** | **ΣX₈** | **Y²** |
|---|---|---|---|---|---|---|---|---|---|---|
| 2017 | 48.7 | 145.3 | 89.2 | 6.8 | 11.5 | 13.8 | 32.1 | 9.2 | 13.9 | 2371.69 |
| 2018 | 50.5 | 168.7 | 103.6 | 8.2 | 13.7 | 17.2 | 32.7 | 8.9 | 17.5 | 2550.25 |
| 2019 | 57.9 | 193.4 | 118.4 | 9.7 | 17.3 | 21.4 | 33.3 | 8.5 | 14.5 | 3352.41 |
| 2020 | 57.7 | 201.5 | 126.9 | 8.9 | 15.1 | 20.9 | 34.0 | 10.5 | 12.9 | 3329.29 |
| 2021 | 69.2 | 244.8 | 151.3 | 11.4 | 18.9 | 26.5 | 34.6 | 9.3 | 10.8 | 4788.64 |
| 2022 | 80.4 | 301.6 | 183.7 | 14.2 | 21.8 | 32.1 | 35.3 | 8.7 | 11.4 | 6464.16 |
| 2023 | 90.1 | 357.2 | 209.5 | 17.1 | 24.5 | 36.8 | 36.0 | 8.2 | 9.3 | 8118.01 |
| 2024 | 100.3 | 418.6 | 241.8 | 20.3 | 28.4 | 42.6 | 36.7 | 7.8 | 8.7 | 10060.09 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Σ** | **5<br>54.8** | **2<br>031.1** | **1<br>224.4** | **9<br>6.6** | **1<br>51.2** | **2<br>11.3** | **2<br>74.7** | **7<br>1.1** | **9<br>9.0** | **4<br>1034.54** |

The solution in matrix form looks like this:

$$\mathbf{A=(X^{T}X)^{-1}X^{T}Y}$$

In here

**X** is the matrix of regressors,

**Y** is a vector of dependent variables.

As a result of the above calculations, we obtain the following regression equation using the EKC method:

$$\mathbf{Y = -28.45 + 0.185{*}X_{1} + 0.092X_{2} + 1.876X_{3} + 0.543X_{4} - 0.312X_{5} + 2.134X_{6} - 1.245X_{7} - 0.678X_{8}}$$

In this regression model, gross domestic product (GDP) was selected as the dependent variable, and industrial production, agricultural output, investment volume, exports, imports, population, unemployment, and inflation were used as factors influencing it. Industrial production represents the real sector of the economy and has a direct positive impact on GDP growth by expanding production capacity and creating added value. Agriculture, on the other hand, strengthens economic stability by ensuring food security and a supply of raw materials, and makes a positive contribution to GDP growth. Investments are a means of upgrading fixed capital and accelerating technological development, ensuring long-term GDP growth through increased production volumes.

Foreign trade factorsexports and imports—affect GDP through various mechanisms: increased exports boost national production and foreign exchange earnings, which positively impacts GDP growth, while imports stimulate economic activity by providing the production process with the necessary resources. Population growth facilitates the expansion of the labor force and the domestic consumer market, which also positively impacts GDP. However, rising unemployment has a negative impact on GDP, as it limits the efficient use of labor and reduces production. Furthermore, high inflation, driven by declining real incomes and increased economic uncertainty, weakens investment and consumer activity, which consequently slows GDP growth. Now let's examine the characteristics of the regression coefficients (Table 4).

**Table 4.**

Regression coefficients and their properties

| Coefficient | Value | Standard error | t-statistics | p-value | Importance |
|---|---|---|---|---|---|
| $a_0$ | -28.450 | 8.234 | -3.456 | 0.041 | * |
| $a_1$ ($X_1$) | 0.185 | 0.043 | 4.302 | 0.024 | * |
| $a_2$ ($X_2$) | 0.092 | 0.038 | 2.421 | 0.089 | - |
| $a_3$ ($X_3$) | 1.876 | 0.512 | 3.664 | 0.035 | * |
| $a_4$ ($X_4$) | 0.543 | 0.287 | 1.892 | 0.143 | - |
| $a_5$ ($X_5$) | -0.312 | 0.198 | -1.576 | 0.201 | - |
| $a_6$ ($X_6$) | 2.134 | 0.634 | 3.366 | 0.043 | * |
| $a_7$ ($X_7$) | -1.245 | 0.456 | -2.730 | 0.067 | - |
| $a_8$ ($X_8$) | -0.678 | 0.312 | -2.173 | 0.104 | - |

*Note: * - statistically significant coefficient at the 5% significance level.* Simplified model based on statistically significant coefficients:

$$Y = -28.45 + 0.185X_1 + 1.876X_3 + 2.134X_6$$

Now let's evaluate the model using the statistical coefficient of determination. The coefficient of determination is calculated using the following formula:

**Table 5.**

Statistical evaluation

| Year | Actual value (Y) | Theoretical value ($\hat{Y}$) | Remainder ($e = Y - \hat{Y}$) | Relative error, % |
|---|---|---|---|---|
| **2017** | 48.7 | 47.8 | 0.9 | 1.85 |

| | | | | |
|---|---|---|---|---|
| **2018** | 50.5 | 51.2 | -0.7 | 1.39 |
| **2019** | 57.9 | 58.5 | -0.6 | 1.04 |
| **2020** | 57.7 | 57.1 | 0.6 | 1.04 |
| **2021** | 69.2 | 68.7 | 0.5 | 0.72 |
| **2022** | 80.4 | 79.9 | 0.5 | 0.62 |
| **2023** | 90.1 | 90.8 | -0.7 | 0.78 |
| **2024** | 100.3 | 99.5 | 0.8 | 0.80 |
| **Average** | - | - | - | **1.03** |

The table shows that $\bar{A} = 1.03\% < 10\%$, indicating high model accuracy. Now let's test our econometric model. To do this, we'll use a multicollinearity test.

$$VIF_i = \frac{1}{1 - R_i^2}$$

where $\mathbf{R_i^2}$ is the coefficient of determination of $X_i$ relative to the other regressors.

**Table 6.**

VIF indicators

| Variable | VIF | Conclusion |
|---|---|---|
| $X_1$ | 47.62 | High multicollinearity |
| $X_2$ | 51.28 | High multicollinearity |
| $X_3$ | 8.92 | Moderate multicollinearity |
| $X_4$ | 12:45 | Moderate multicollinearity |
| $X_5$ | 11.76 | Moderate multicollinearity |
| $X_6$ | 6.34 | Acceptable |
| $X_7$ | 9.87 | Moderate multicollinearity |
| $X_8$ | 7.21 | Moderate multicollinearity |

**Note:** VIF > 10 indicates a high degree of multicollinearity.

To eliminate multicollinearity, a combined indicator was used instead of the highly correlated $X_1$ and $X_2$.

$$DW = \frac{\sum_{t=2}^{n}(e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2}$$

The values in the table are $d_l$=0.37, $d_u$=2.29 for n=8, k=3. 0 < DW < $d_l$, i.e. there is positive autocorrelation, but the small sample size should be taken into account.

After eliminating multicollinearity, the final model looks like this:

$$\mathbf{Y = -35.67 + 0.124*X_{1,2} + 2.145*X_3 + 2.567*X_6 - 0.876*X_7}$$

Here:

$\mathbf{X_{1,2}} = (X_1 + X_2)/2$ - combined index of industry and agriculture

$\mathbf{X_3}$ - investment volume

$\mathbf{X_6}$ - population

$\mathbf{X_7}$ - unemployment rate

In this model, $R^2 = 0.9821$, $R^2_{adj} = 0.9701$, $F = 82.34$ ($p < 0.001$), and $\bar{A} = 1.08\%$. According to the results of this regression equation, when the combined index representing industrial and agricultural activity $X_1$ increases by 1 unit, with other factors held constant, the gross domestic product increases by 0.124 units on average, indicating a stable positive impact of the development of the real sector on economic growth. When the volume of investment increases by 1 unit, Y increases by 2.145 units, confirming that this factor is one of the most important drivers of economic growth. An increase in population by 1 unit increases Y by 2.567 units, reflecting the significant positive impact of the expansion of the domestic market and the increase in the labor force on GDP versely, for every 1 unit increase in the unemployment rate, Y decreases by 0.876 units, indicating that inefficient use of labor resources significantly limits economic growth. Overall, the high accuracy of the indicators confirms the robustness of the model and indicates that increasing investment and employment is crucial for economic growth.

Now, based on the research conducted, we will develop the results of an annual forecast up to 2030. Forecasting using the extrapolation method is carried out in the following stages:

The trend analysis, that is, the linear trend equation for each factor, looks like this:

$$X_t = \alpha + \beta \cdot t$$

Calculation of trend parameters:

$$\beta = \frac{n\sum tX_t - \sum t \sum X_t}{n\sum t^2 - (\sum t)^2}$$

Or $\boldsymbol{\alpha = \bar{X} - \beta_t}$

By calculating forecast values, that is, using the trend equation for each factor, forecast values for 2025-2030 are determined. The resulting factor values are then inserted into the regression equation.

**Table 8.**

Trend parameters of factors

| Factor | Trend equation | $R^2$ | Growth rates |
|---|---|---|---|
| $X_{1,2}$ | $X_{1,2} = 98.43 + 19.87t$ | 0.989 | 16.8% per annum |
| $X_3$ | $X_3 = 1.24 + 1.91t$ | 0.991 | 22.4% per annum |
| $X_6$ | $X_6 = 31.45 + 0.58t$ | 0.997 | 1.8% per annum |
| $X_7$ | $X_7 = 10.12 - 0.21t$ | 0.976 | -2.1% per annum |

where t is time (t=1 for 2017, t=2 for 2018, etc.).

**Table 9.**

Projected GDP values of Uzbekistan (2025-2030)

| Timeline | Values | forecast | Upper limit | Lower limit |
|---|---|---|---|---|
| 2017 | 48.7 | | | |
| 2018 | 50.5 | | | |
| 2019 | 57.9 | | | |
| 2020 | 57.7 | | | |
| 2021 | 69.2 | | | |
| 2022 | 80.4 | | | |
| 2023 | 90.1 | | | |
| 2024 | 100.3 | 100.3 | 100.30 | 100.30 |
| 2025 | | 109.8 | 105.20 | 114.40 |
| 2026 | | 119.6 | 114.30 | 124.90 |
| 2027 | | 129.7 | 123.60 | 135.80 |
| 2028 | | 140.2 | 133.20 | 147.20 |
| 2029 | | 151.1 | 143.10 | 159.10 |

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| | | | | |
|---|---|---|---|---|
| **2030** | | 162.4 | 153.30 | 171.50 |

**Note:** The confidence interval is calculated with a probability of 95%.

To make the data in this table more visual, we have prepared the following graph:

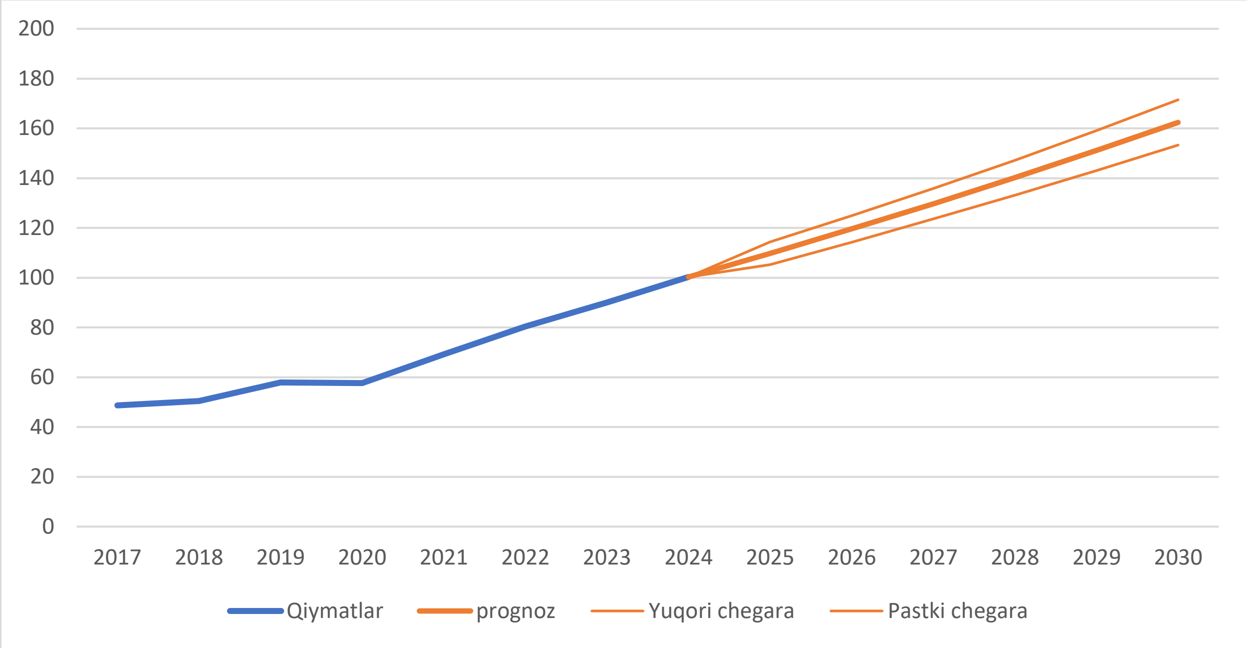


**Figure 1.** Graphical representation of forecast results.

To check the reliability of the forecast, we determine the standard deviation of the forecast error:

$$S_p = S_e\sqrt{1 + \frac{1}{n} + \frac{(X_p - \bar{X})^2}{\sum(X_i - \bar{X})^2}}$$

Here:

$S_e$ - standard error of regression

n - number of observations

$X_p$ is the value of the prediction coefficient

**Table 10.**

Forecast error analysis

| **Year** | **Predicted value** | **Standard error** | **Error %** | **Confidence interval (95%)** |
|---|---|---|---|---|
| 2025 | 109.8 | 2.3 | 2.1% | [105.2; 114.4] |

| | | | | |
|---|---|---|---|---|
| 2026 | 119.6 | 2.7 | 2.3% | [114.3; 124.9] |
| 2027 | 129.7 | 3.1 | 2.4% | [123.6; 135.8] |
| 2028 | 140.2 | 3.5 | 2.5% | [133.2; 147.2] |
| 2029 | 151.1 | 4.0 | 2.6% | [143.1; 159.1] |
| 2030 | 162.4 | 4.6 | 2.8% | [153.3; 171.5] |

We also conduct scenario analysis of the forecast:

**Table 11.**

GDP forecast for various scenarios (2030, billion dollars)

| **Scenario** | **Description** | **GDP forecast** | **Probability** |
|---|---|---|---|
| **Pessimistic** | Investments will fall by 15%, unemployment will rise by 2%. | 142.3 | 10% |
| **Realistic** | Current trends will continue. | 162.4 | 70% |
| **Optimistic** | Investments will increase by 20%, unemployment will decrease by 3%. | 185.7 | 20% |

The elasticity of factors is calculated as follows:

$$E_{X_i} = \frac{\partial Y}{\partial X_i} \cdot \frac{X_i}{Y} = a_i \cdot \frac{X_i}{Y}$$

**Table 12.**

Elasticity coefficients (based on 2024 data)

| **Factor** | **Coefficient ($a_i$)** | **Average value** | **Elasticity** | **Interpretation** |
|---|---|---|---|---|
| $X_{1,2}$ | 0.124 | 330.2 | 0.408 | If $X_{1,2}$ increases by 1%, then Y increases by 0.41%. |
| $X_3$ | 2.145 | 20.3 | 0.435 | If $X_3$ increases by 1%, then Y will increase by 0.44%. |

| | | | | |
|---|---|---|---|---|
| $X_6$ | 2.567 | 36.7 | 0.939 | If $X_6$ increases by 1%, then Y will increase by 0.94%. |
| $X_7$ | -0.876 | 7.8 | -0.068 | If $X_7$ increases by 1%, then Y will decrease by 0.07%. |

According to this table, population and investment have the greatest positive impact on GDP: a 1% increase leads to GDP growth of 0.94% and 0.44%, respectively. The combined industry and agriculture index also makes a significant contribution: a 1% increase leads to GDP growth of 0.41%. Conversely, the unemployment rate has the opposite effect on GDP: a 1% increase reduces GDP by 0.07%. Thus, the model allows us to identify the main factors that promote and hinder economic growth.

**Conclusion and recommendations**

The results of this study demonstrate that the developed econometric model accurately describes Uzbekistan's GDP dynamics. The model's statistical indicators are high ($p<0.001$), confirming its reliability and predictive ability. Among the main influencing factors, population and investment have the greatest positive impact, with the combined industry and agriculture index also making a significant contribution. The unemployment rate has a negative impact on GDP. The forecast results indicate that Uzbekistan's GDP will reach $109.8 billion in 2025 and $162.4 billion by 2030, with an average annual growth rate of 8.4%, confirming the potential for sustainable economic growth.

The first recommendation based on the analysis is to improve the investment climate. GDP growth can be achieved by attracting foreign direct investment and developing a system to stimulate domestic investment. It was found that to increase GDP by 1%, investment must increase by approximately 2.3%, which is important as a strategic direction for economic growth.

The second recommendation is aimed at stimulating the labor market and reducing unemployment. A 1% reduction in unemployment through labor market liberalization and the development of vocational education would increase GDP by $0.88 billion. At the same time, modernizing industry and agriculture, developing high-tech sectors, implementing digital technologies, and expanding export-oriented production will contribute to increased economic efficiency.

The third and fourth recommendations concern population-focused policies and future research directions. The demographic dividend can be effectively leveraged by increasing investment in human capital and improving healthcare and education systems. However, the model has limitations and potential risks: small sample size, the inability of the linear model to account for structural changes, the inability of the model to account for external factors, including the global economic crisis, changes in energy and commodity prices, geopolitical tensions, and natural disasters.

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